

4.8 GEOLOGY/SOILS

This section assesses general geologic conditions and identifies potential geologic impacts, geotechnical hazards, and effects to mineral resources within Carlsbad. This analysis is based on information contained in applicable resource and planning documents and pertinent geological and soils reports and maps for the City of Carlsbad and San Diego County.

4.8.1 Existing Conditions

4.8.1.1 Program Level

Soils

Carlsbad contains seven general soil associations as mapped by the United States Department of Agriculture (USDA 1973). Soils associations are useful for developing a general idea of the soils in an area and for determining the value of an area for certain uses. The following discussion outlines these soil classifications.

Marina-Chesterton Association: This association occurs on broad rolling ridges parallel to the coast and consists of excessively well-drained to moderately well-drained loamy coarse sands and fine sandy loams that have a subsoil of sandy clay over a hardpan.

Salinas-Corralitos Association: This association consists of moderately well-drained to somewhat excessively drained clays, clay loams, and loamy sands on alluvial fans, and occurs on coastal plains.

Cieneba-Fallbrook Association (Very Rocky): This association is composed of soils that developed in material weathered in-place from decomposed tonalite or granodiorite and generally occurs in the foothills.

Exchequer-San Miguel Association: This association consists of rocky, well-drained silt loams over metavolcanic rock, developed from hard metavolcanic rock, and generally occurs in the foothills.

Diablo-Altamont Association: Well-drained clays are the major characteristic of this association, formed from marine sandstone, shale and breccia. This association occurs in the rolling uplands of the coastal plains.

Diablo-Las Flores Association: This association consists of soils derived from calcareous and noncalcareous marine sandstone and shale and occurs in the coastal plains. Diablo soils are well-drained, dark-gray clays, while Los Flores soils are moderately well-drained fine sandy loam with a subsoil of sandy clay loam.

Las Flores-Huerhuero Association: This association occurs in the coastal plains and is composed of soils that develop in material derived from sandstone or marine sediments. The soils consist of moderately well-drained loamy fine sands to loams that have a subsoil of sandy clay or clay.

Faults and Seismic Hazards

The San Diego region faces the potential for substantial damage associated with seismic and geologic activity. Earthquake faults occur in and through the urban areas of the region, increasing the potential of earthquake damage to structures and potentially endangering the safety of the area's inhabitants. Most damage from earthquake activity results from ground movement, causing ground shaking, surface fault rupture, landslides and mudslides, liquefaction, and tectonic subsidence or uplift. Ground shaking is the oscillation or vibration of earth materials and causes the greatest amount of damage during an earthquake. Ground-shaking hazards usually occur in areas underlain by loose, water-saturated, unstable materials. Surface fault rupture results from the intersection of the ground surface with fault displacement.

The study area for the DMP Update is not located near a known fault, and Carlsbad is not listed as a city potentially affected by earthquake fault zones (CDC 1997). The nearest known active fault is the northern extension of the Rose Canyon fault, which originates in Mission Bay, drops off into the Pacific Ocean at La Jolla Shores, and then runs north several miles off the coast to Oceanside. Regional fault systems, including the San Jacinto, San Andreas, and Elsinore faults are located to the east and north of Carlsbad.

Strong vibratory motion resulting from seismic activity can cause liquefaction and dynamic settlement of soils, such as loose, granular soils. Finer-textured granular soils are more susceptible to liquefaction than coarse-grained types, and soils of uniform grain size are more likely to liquefy than well-graded materials. Most silty clay and clay soils are not adversely affected by vibratory motion. There are limited areas in Carlsbad that are considered potentially subject to liquefaction, including areas west of El Camino Real, land within and adjacent to the lagoons, and areas along the coastline (City of Carlsbad 1994). The city is not located in a mapped Alquist-Priolo fault zone area (CDC 1997).

Mineral Resources

Mineral resources within Carlsbad are no longer being extracted and utilized as exploitable natural resources. There are several abandoned oil wells and gravel pit operations within the city limits, as well as two abandoned salt evaporation ponds; one is near the south shore of Buena Vista Lagoon and the other one is north of La Costa Avenue near the eastern perimeter of Batiquitos Lagoon (City of Carlsbad 1994). The only area with mineral resources delineated in the General Plan EIR is located around Calavera Hills/Robertson Ranch, west of Lake Calavera. The remaining mineral resources in the city are not planned for future extraction and the area is designated for urban development in the General Plan. No program level PLDA or non-PLDA components are proposed within an area where mineral resources are known to be present.

4.8.1.2 Project Level

Soils

There are four soil series that underlay the Agua Hedionda and Calavera creeks within the limits of work: Huerhuero (9 to 15 percent slopes), Salinas clay loam (0 to 2 percent slopes and 2 to 9 percent slopes), Tujunga (0 to 5 percent slopes), and Riverwash (USDA 1973). The Huerhuero loam soil series consists of moderately well-drained loams that have clay subsoil and occur along Calavera Creek, at the north end of Cannon Road. The Huerhuero soil series contains clay loam components, which are considered an expansive soil type, and have high shrink-swell behavior (USDA 1973). The eastern portion of Agua Hedionda Creek is underlain by Salinas clay loam, which consists of well-drained and moderately well-drained clay loams. The Salinas series has moderate shrink-swell behavior, and Tujunga sand and Riverwash, found along the creeks, have low shrink-swell behavior and are not considered expansive soil types.

The presence of shallow groundwater and the relatively granulated nature of the soils underlying the site create a moderate potential for liquefaction and seismically induced settlement (Ninyo & Moore 2004).

Faults and Seismic Hazards

The nearest known active fault to the proposed project boundary area is the northern extension of the Rose Canyon fault located approximately 7 miles to the west offshore, as described above. A geotechnical evaluation was prepared for the project to determine the geotechnical conditions of the proposed DMP Update site and provide recommendations for design and earthwork

construction measures for the project (Ninyo & Moore 2004). The investigation found no evidence of faulting on the site.

Mineral Resources

Mineral resources are not known to occur within the proposed work area. No locally important mineral resource recovery sites have been identified within the proposed work area (City of Carlsbad 1994).

4.8.2 Significance Criteria

The DMP Update would result in potentially significant impacts to geology or soils if it would:

- expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
 - rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault,
 - strong seismic ground shaking,
 - seismic-related ground failure, including liquefaction, or
 - landslides;
- result in substantial soil erosion or the loss of topsoil;
- be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse; or
- be located on expansive soils, as defined in the 1997 Uniform Building Code, creating substantial risks to life or property; or
- result in the loss of availability of a locally important mineral resource.

4.8.3 Impact Analysis

4.8.3.1 Program Level

Soils

Impacts associated with the proposed DMP Update project components that would involve excavation, grading, or construction of new structures could include encountering unstable soil and rock conditions and exposure of oversize rock material during grading. The specific soil types and rock formations impacted by each DMP Update component are unknown at this time, as site-specific geotechnical analyses were not performed for individual components. Construction of proposed DMP Update components could result in potential hazards resulting from expansive or unstable soils and rock conditions. A geotechnical investigation would be required prior to construction of individual projects involving excavation, grading, or construction of new structures, to determine if there are expansive soils or rock formations within the proposed construction area, that would require special remediation measures. Following a site-specific geotechnical evaluation for applicable projects, additional information regarding content, expansiveness, stability, potential for subsidence, and compactibility would be determined during planning and design of individual project components. Appropriate remediation would be incorporated into project design to minimize impacts associated with soils. Potential impacts would be less than significant.

During the construction of proposed project components, erosion could be accelerated, which could undermine slopes, create siltation of surface waters, and expose and damage underground facilities. As described in Table 3-6, all construction would be performed in accordance with the requirements of the City's Grading Ordinance (Municipal Code Title 15), which requires the control of erosion during construction and the stabilization of all disturbed surfaces upon completion of construction (City of Carlsbad 1994). Thus, the proposed projects would not result in substantial soil erosion or substantial losses of topsoil. Potential impacts would be less than significant.

Faults and Seismic Hazards

The study area is located within seismically active San Diego County. However, the proposed DMP Update components would not traverse any known faults within the county. The proposed DMP Update components may be subject to local seismically induced secondary effects related to liquefaction, lateral spreading, local subsidence of soil, and vibration damage. Geotechnical

investigations would be required prior to design of each component to identify impacts related to faults and seismic hazards and develop appropriate remediation. Additionally, the requirements of the City Building Code (Carlsbad Municipal Code, Title 18) and the Uniform Building Code requirements would be incorporated into project component design to minimize the threat of damage to structures associated with seismic instability, subsidence, liquefaction, and stability, which would minimize impacts related to seismic hazards. Potential impacts would be less than significant.

Mineral Resources

Extraction of mineral resources is not proposed as part of the project. The South Coast Materials Company Carlsbad Quarry is located immediately south of the intersection of SR 78 and College Boulevard approximately 0.75 mile away from the nearest proposed project component (DMP Update component AFB). Extraction operations at the quarry have ceased. There would be no impacts to the known aggregate resources associated with the quarry. There are no mineral resources recovery sites designated within the City's General Plan (City of Carlsbad 1994). Therefore, no impacts related to the loss of availability of a locally important mineral resource recovery site are anticipated from implementation of proposed DMP Update project components.

4.8.3.2 Operation and Maintenance

Operation and maintenance activities would occur in existing or proposed drainage facilities and would not involve the construction of new structures. Assuming a site-specific geotechnical analysis would be conducted for proposed PLDA and non-PLDA components and site-specific remediation measures would be incorporated into facility project design, no additional impacts due to soils or seismic activity are anticipated to occur from routine operation and maintenance of built facilities.

During some operation and maintenance activities within natural channels, erosion could be accelerated, which could undermine slopes, create siltation of surface waters, and expose and damage underground facilities. As described in Table 3-6, all operation and maintenance would be performed in accordance with the requirements of the City's Grading Ordinance (Municipal Code Title 15), which requires the control of erosion during construction and the stabilization of all disturbed surfaces upon completion of construction (City of Carlsbad 1986). Due to conformance with the City's Grading Ordinance, it is not anticipated that the proposed project would result in substantial soil erosion or significant losses of topsoil. Potential impacts would be less than significant.

4.8.3.3 Project Level

This analysis of impacts to geology and soils applies to proposed project level PLDA and non-PLDA project components B and BN.

Soils

As described in Chapter 3.0 (Project Description), the project involves slope stabilization and enhancement along the creeks to address existing erosion problems. Additionally, the long-term maintenance plan involves periodic inspections and repair of eroded slopes. Providing that construction, dredging, and maintenance activities conform to the erosion control requirements of the City, substantial erosion and loss of topsoil are not anticipated.

The proposed drainage improvements in Agua Hedionda and Calavera creeks would not involve any new septic tanks or alternative waste disposal systems. However, the project would involve bank and channel excavation and installation of drop structures, drains, and an access road where expansive soils potentially occur. Design of the project components would incorporate BMPs and erosion-prevention measures to address issues related to expansive soils and stabilize the banks of the creeks, including:

- incorporating standards from current seismic design code;
- using slope stabilization material, such as Vmax;
- for slopes higher than 12 feet, retaining 2:1 (H:V) side slope design for slope stability;
- planting a combination of shallow and deep-rooted vegetation to provide slope stability;
- performing fill placement (if needed) in accordance with the typical earthwork guidelines (Ninyo & Moore 2004);
- engineering surface drainage away from the top of slopes and maintaining drainage features such as berms, swales, collectors, pipes, and energy dissipaters; and
- implementating the long-term maintenance plan (Appendix B), including inspection and repair of the channel banks.

Overall, potential impacts to soils would be less than significant.

Faults and Seismic Hazards

A geotechnical evaluation found no evidence of faulting within the project limits (Ninyo & Moore 2004). Therefore, there would be no substantial adverse effects due to a fault rupture from the proposed components. The project area could experience seismic ground shaking due to the nearest known active fault, Rose Canyon fault (Ninyo & Moore 2004). However, the requirements of the City Building Code (Carlsbad Municipal Code Section 18) and the 2001 Uniform Building Code would be implemented as part of the project components design to minimize the threat of construction damage associated with seismic activity. The presence of shallow groundwater and the relatively granulated nature of the soils underlying the site create a moderate potential for liquefaction and seismically induced settlement (Ninyo & Moore 2004). Catastrophic ground failure is not considered likely as a result of development in the area. The proposed DMP Update area is not located in a potential landslide zone. The proposed DMP Update would not increase human exposure to seismic ground failure beyond existing conditions. Based on the relatively flat topography, project implementation would not increase the potential for landslides or instability. Therefore, it is not anticipated that people or buildings would be exposed to landslides resulting from implementation of the project components. Potential impacts related to faults and seismic hazards would be less than significant.

Mineral Resources

Project components B and BN would be located almost 2 miles from the South Coast Materials Company Carlsbad Quarry, which is no longer in operation. As noted in the program level analysis, no mineral resources recovery sites are designated within the city, and no impacts related to loss of availability of a locally important mineral resource recovery site are anticipated.

4.8.4 Significance of Impacts

4.8.4.1 Program Level

Implementation of program level DMP Update components is not anticipated to result in direct or indirect potentially significant short- or long-term impacts related to geology/soils.

4.8.4.2 Operation and Maintenance

No direct or indirect short- or long-term potentially significant impacts to geology/soils are anticipated as a result of operation and maintenance activities.

4.8.4.3 Project Level

Implementation of project level DMP Update components are not anticipated to result in direct or indirect potentially significant short- or long-term impacts related to geology/soils.

4.8.5 Mitigation Measures

4.8.5.1 Program Level

No potentially significant impacts were identified for program level DMP Update components; therefore, no mitigation would be required.

4.8.5.2 Operation and Maintenance

No potentially significant impacts were identified for operation and maintenance activities; therefore, no mitigation would be required.

4.8.5.3 Project Level

No potentially significant impacts were identified for project level DMP Update components; therefore, no mitigation would be required.

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